

**CLAIMS****WHAT IS CLAIMED IS:**

- 5           1. An implantable cardiac stimulation device for stimulating a heart,  
the device comprising:  
a physiologic sensor that is capable of sensing a physiologic  
parameter and generating corresponding signals;  
one or more pulse generators that are capable of generating  
10 cardiac pacing pulses;  
circuitry connected to the sensor that is operative to detect a  
potential sleep apnea condition based on the signals and  
that is responsive to detection of a potential sleep apnea  
condition to control the one or more pulse generators to  
15 pace the heart at a sleep apnea prevention rate.
2. An implantable cardiac stimulation device according to Claim 1  
further comprising:  
a controller coupled to the one or more pulse generators and to the  
20 physiologic sensor, the controller comprising an executable  
control logic that distinguishes between a sleeping condition  
and a waking condition of a patient, and controls the one or  
more pulse generators to pace at a sleep apnea prevention  
rate in response to detection of a sleeping condition.
- 25 3. An implantable cardiac stimulation device according to Claim 1  
further comprising:  
one or more sensors that are capable of electrical coupling to the  
cardiac tissue;  
30 a controller coupled to the one or more pulse generators, the one  
or more sensors, and the physiologic sensor, the controller

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including an executable control logic that controls the one or more pulse generators to pace at a rate selected from among at least a sleeping rate, a resting rate, and an exercising rate, the executable control logic being capable of distinguishing between a sleeping condition and a waking condition of a patient, and controlling the one or more pulse generators to pace at a rate greater than the resting rate in response to detection of a sleeping condition.

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10 4. An implantable cardiac stimulation device according to Claim 1 further comprising:

a physiologic sensor that measures physical motion for derivation of an activity parameter and an activity variance parameter, and activates sleep apnea preventive pacing when the activity and activity variance signals indicate a sleeping condition.

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5. An implantable cardiac stimulation device according to Claim 1 further comprising:

20 a physiologic sensor that measures QT interval and activates sleep apnea preventive pacing when the QT interval exceeds a threshold value.

25 6. An implantable cardiac stimulation device according to Claim 1 further comprising:

a physiologic sensor that measures cardiac conductivity and activates sleep apnea preventive pacing when cardiac conductivity is depressed during sleep.

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7. An implantable cardiac stimulation device according to Claim 1 further comprising:

5 a physiologic sensor that measures cardiac contractility and activates sleep apnea preventive pacing when cardiac contractility is reduced during sleep.

8. An implantable cardiac stimulation device according to Claim 1 further comprising:

10 a physiologic sensor that measures evoked response amplitude and evoked response duration and activates sleep apnea preventive pacing when evoked response amplitude is decreased and evoked response duration is increased during sleep.

15 9. An implantable cardiac stimulation device according to Claim 1 further comprising:

20 a physiologic sensor that measures evoked response amplitude and evoked response duration and activates sleep apnea preventive pacing when evoked response amplitude is decreased and evoked response duration is increased during sleep; and

a physiologic sensor that measures paced depolarization integral (PDI) and activates sleep apnea preventive pacing when PDI is depressed during sleep.

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10. An implantable cardiac stimulation device according to Claim 1 further comprising:

30 a physiologic sensor that measures stroke volume and activates sleep apnea preventive pacing when stroke volume increases when a patient is in a supine position.

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11. An implantable cardiac stimulation device according to Claim 1 further comprising:

5 a physiologic sensor that measures paced depolarization integral (PDI) and activates sleep apnea preventive pacing when PDI is depressed during sleep.

12. An implantable cardiac stimulation device according to Claim 1 further comprising:

10 a physiologic sensor that measures blood oxygen concentration and activates sleep apnea preventive pacing when blood oxygen concentration is depressed during sleep.

13. An implantable cardiac stimulation device according to Claim 1 further comprising:

15 a physiologic sensor that measures blood carbon dioxide concentration and activates sleep apnea preventive pacing when blood carbon dioxide concentration is elevated during sleep.

20 14. An implantable cardiac stimulation device comprising:  
means for detecting a potential sleep apnea condition;  
means for generating cardiac pacing pulses; and  
means for controlling the means for generating cardiac pacing  
pulses to pace at a sleep apnea prevention rate in response  
25 to detection of a potential sleep apnea condition.

15. An implantable cardiac stimulation device according to Claim 14 wherein the means for detecting a potential sleep apnea condition comprises means for detecting a sleep condition.

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16. An implantable cardiac stimulation device according to Claim 14 further comprising:

means for distinguishing between a sleeping condition and a waking condition of a patient.

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17. An implantable cardiac stimulation device according to Claim 14 wherein the means for detecting comprises at least one of:

a physiologic sensor that measures physical motion for derivation of an activity parameter and an activity variance parameter, and activates sleep apnea preventive pacing when the activity and activity variance signals are reduced during sleep;

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a physiologic sensor that measures QT interval and activates sleep apnea preventive pacing when QT interval is prolonged during sleep;

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a physiologic sensor that measures cardiac conductivity and activates sleep apnea preventive pacing when cardiac conductivity is depressed during sleep;

a physiologic sensor that measures cardiac contractility and activates sleep apnea preventive pacing when cardiac contractility is reduced during sleep;

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a physiologic sensor that measures evoked response integral amplitude and evoked response duration and activates sleep apnea preventive pacing when evoked response integral amplitude is decreased and evoked response duration is increased during sleep;

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a physiologic sensor that measures stroke volume and activates sleep apnea preventive pacing when stroke volume increases when a patient is in a supine position;

a physiologic sensor that measures paced depolarization integral (PDI) and activates sleep apnea preventive pacing when PDI is depressed during sleep; and

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a physiologic sensor that measures blood oxygen concentration  
and activates sleep apnea preventive pacing when blood  
oxygen level is depressed during sleep.

5           18. A method of operating an implantable cardiac stimulation  
device comprising:  
detecting a potential sleep apnea condition; and  
generating cardiac pacing pulses at a sleep apnea prevention rate  
in response to detection of the potential sleep apnea  
10           condition.

19. The method of claim 18, wherein detection a potential sleep  
apnea condition comprises detecting a sleeping state of a patient.

15           20. A method according to Claim 18 further comprising:  
distinguishing between a sleeping condition and a waking condition  
of a patient;  
timing generation of the cardiac pacing pulses; and  
controlling the timed cardiac pacing pulses at a sleep apnea  
20           prevention rate.

21. A method according to Claim 18 further comprising:  
distinguishing between a sleeping condition and a waking condition  
of a patient; and  
25           timing cardiac pacing pulse generation to pace at a rate greater  
than the resting rate in response to detection of a sleeping  
condition.

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